

*Measures of the Great B Line in the Spectrum of a High Sun.*

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It is not known, I believe, as yet, by any direct experiment, to what chemical element, or elements, the B line in the solar spectrum is to be attributed. In its main part, if not also in its entirety, it must be of telluric, rather than solar, origin—because it is one of those lines which darken egregiously, and thicken also, when the C line of solar hydrogen does not, as the setting Sun approaches the horizon; a duplicate fact observed by me so far back as 1856, on the peak of Teneriffe. But it is more the *beauty* of the B line which has been of late dwelt on by observers possessing very powerful spectroscopes. “The most beautiful line in the whole solar spectrum” is a remark in one of his many optical papers by the accomplished Mr. Rutherford, of New York, probably the greatest master of line drawing and most consummate judge of geometrical symmetry and mechanical perfection in the whole world.

In what, then, does the alleged beauty of the said B line consist? I presume the answer will greatly depend on the degree of telluric development under which the line may have been viewed by each observer; always assuming that everyone means equally to express by “the line B” the whole congeries of lines forming both the attached band and the preliminary band to the actual line B; which, moreover, even in itself, is anything but a simple, single, line when in presence of still more penetrating examination.

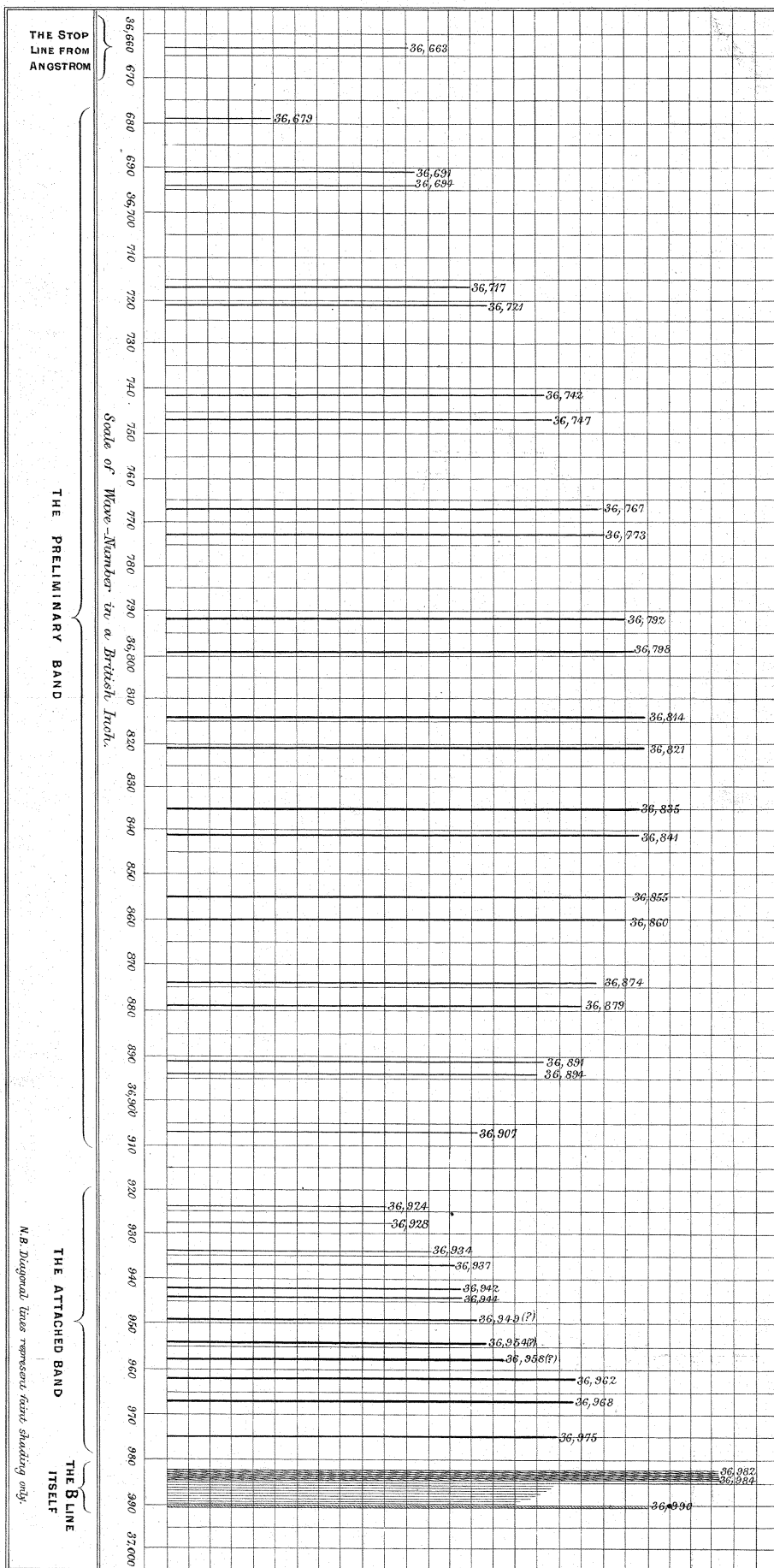
Generally, however, and to all inhabitants of northern countries at least, where the Sun can never be observed very near the zenith, and therefore not through a zenithal *minimum* thickness of the Earth’s atmosphere, the almost proverbial *beauty* of the great B line must consist in the rhythmical arrangement of the powerful lines forming the preliminary band to B and its attached band of finer, closer-set lines, or even linelets. Forcible, dark lines the former are, clean edged, well defined, no one of them exactly like another, either in thickness, or depth of colour, or distance from its neighbour on either side; and yet the whole forming a harmonious group, from which not one element could be taken away, and to which not one could be added, without introducing a discord and spoiling the entire system.

Such, I am quite aware, is *not* the manner of representation of the preliminary band of B, either for a high or a low Sun, in the Royal Society’s second publication of such a spectrum as seen in the Himalayas; for they make it like a uniform fence of thin wires in one case, and of thick bars in the other. Nor is it like the unfortunate blotches which have unhappily resulted to Kirchhoff’s originally good spectrum map, from having latterly passed through many lithographic copyings, by hands adopting that method dangerous to all accuracy, of supplementing the imper-

# THE GREAT B LINE AND ITS BANDS IN A HIGH SUN SPECTRUM; LISBON, JUNE, 1878.

(The lines are represented higher in proportion to their intensity.)

P. S. del.



fections of their first stone for black ink printing by other stones printing tints only, and seldom registering exactly. But my description does come very close to the admirable reproduction of B in Angstrom's normal solar spectrum; printed from stone also, but at one printing only, and from lines incised through a thin gum coating on the prepared surface of the stone, or rather into its very substance, and therefore as certain and secure as if engraved on a copper plate.

I had often admired the beauty of symmetry in Angstrom's "great B," and had seen something very like it when observing the solar spectrum last year at Cintra, merely with my aurora spectroscope; but what I saw then by no means prepared me for the transcending beauty of what beamed forth this year, with a better prepared solar spectroscope, and in the highest Sun which mid-day, at the summer solstice, could offer in Lisbon.

And pray what formed the beauty of the B line, then and there, do you ask? Unwilling to trust my own eyes alone, I asked my Wife to look into the telescope, and immediately came the exclamation, "Oh! the beautiful double lines!" Exactly so! each of the usually seen thick lines was now a double line, or rather showed two lines; so perfectly free from any filling up, even with the faintest haze, was the space between the components of any and every pair; while every line was so almost infinitely fine, but at the same time infinitely sharp, clear, and well defined on either side, and such perfect order and symmetry pervaded the whole arrangement, that it was a case *par excellence* of science and art combined.

With prism dispersions from 28 to 50 degrees between A and H, and a magnifying power of 20 on the telescope of inspection, the above features were abundantly distinct; and still further detail could, by careful attention, be made out in the closer system of the *attached* band of B.

This has always been rather a difficult subject. Wherefore in Brewster and Gladstone's enlarged view of B in the *Philosophical Transactions* for 1860, they show an anomalously large opening between the B line and its now so-called "attached band." While Angstrom, usually so trustworthy, and so powerful too at the red end of the spectrum, merely has a telluric shading, all but vanishing for a high Sun, and four single separate lines, of apparently foreign, though perhaps solar, character, in place of the attached band of B.

My published view of that band last year was confessedly imperfect and approximate only; but this year, while again establishing that there is such a band existing even in an almost zenith Sun, the earlier lines composing it were found to be a set of exquisitely close doubles, every one of them. While amongst the later ones were found some stronger single lines, partly confirmatory of Angstrom, and partly, from their greater distance asunder, confirming, or rather apologising for, the actual opening in Brewster and Gladstone's view.

Lastly, we come to the very B line itself; black and thick enough for anything in most plates published hitherto; but, in the highest Sun of Lisbon, shown to consist of a wonderful grouping of the finest possible lines. First a bundle of half a dozen or more, closely packed together into a shape like a Roman lictor's rod, so that, with smaller dispersion or worse definition, it would certainly be set down as a single, though clumsy and coarse, line; then a pale space, just indicating its composition of the feeblest, closest, and most uniform lines possible; and then a stronger line terminating the same space, and finishing off this marvellous and most compound arrangement spoken of so familiarly hitherto as merely "the great B line."

Seeing that the group—constellation almost—has such a decided and well marked physiognomy, and as the harmony and symmetry pervading all its lines of construction—except perhaps the few single lines seen in, or projected upon, the attached band—show it to be dependent on one element or elementary combination, and not to be the result of a chance coming together of stray lines from all sorts of alien elements scattered through the rest of the spectrum, I append both a record of my micrometer measures, though far from positively accurate, and a graphical representation; fervently hoping that by aid of it, notwithstanding its manifold imperfections, the chemists may one day succeed in finding a substance which, under *some* temperature or pressure, may present just such a picture, but in bright lines; and then there will be no sort of doubt at all, as to "what makes the great B line."

November 4, 1878.

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*Postscript.*—(Nov. 22, 1878.)—Having received from Paris this morning a copy of the Second Edition of the late P. Secchi's *Le Soleil* (1875), I find at p. 285, vol. i., in his special "Description du spectre solaire," the following very apposite remark touching the chief subject of this paper:—

"Certaines bandes qui, dans les instruments ordinaires, paraissent comme estompées, sont en réalité composées d'un grand nombre de lignes parfaitement distinctes, comme on le voit avec un spectroscopie ayant un grand pouvoir dispersif; mais quelques-unes d'entre elles sont réellement diffuses sur les bords, et il est impossible de les décomposer, quelle que soit la puissance de l'instrument que l'on emploie. Nous pouvons citer comme exemple les raies du groupe B."

Hence it would appear pretty certain, though I have not been able to find in the book any account of direct and particular attempts to resolve the lines of B, that what was accomplished last June in Lisbon, and is detailed in the present paper, is happily more than that laborious and brilliant spectroscopist, the regretted P. A. Secchi, S.J., had himself seen, or even expected would ever be seen "in the group B" by anyone else.



Collected Micrometer Measures, reduced to Spectrum Place by Wave-number in a British Inch, of the Great B Line and its Bands,  
founding on Angstrom's Normal Solar Spectrum.

Object observed.	Rudely estimated Intensity.	Obs. of June 15, 1878, 1st 30m a.m. Dispersion 39°.	Obs. of June 19, at 11 <sup>h</sup> 50m a.m. Dispersion 50°.	Obs. of June 19, at 3 <sup>30</sup> p.m. Dispersion 50°.	Concluded Mean for every Line.	Single Lines and Centres of Double Lines.	Differences.	
							Width of	Dist. of
							Doubles.	sides.
							centres.	
Previous stop line, place assumed from Angstrom	1.5	36,663	36,663	36,663	36,663	36,663		
A very faint line	0.1			(36,679)	(36,679)	(36,679)	28	31
PRELIMINARY BAND.								
First pair, Component 1	0.5	36,690	36,689	36,692	36,691	36,692	3	
2	0.5	692	692	695	694			23
Second pair, Component 1	0.7	36,715	36,718	36,718	36,717	36,719	4	27
2	0.7	718	721	723	721			21
Third pair, Component 1	1.0	36,741	36,742	36,743	36,742	36,744	5	25
2	1.0	746	746	748	747			20
Fourth pair, Component 1	1.5	36,767	36,766	36,768	36,767	36,770	6	26
2	1.5	773	771	774	773			19
Fifth pair, Component 1	1.8	36,793	36,790	36,792	36,792	36,795	6	25
2	1.8	800	796	798	798			16
								22

Object observed.	Rudely estimated Intensity.	Obs. of June 15, 1878, 10 <sup>h</sup> 30 <sup>m</sup> a.m. Dispersion 39°.	Obs. of June 19, at 1 <sup>h</sup> 50 <sup>m</sup> a.m. Dispersion 50°.	Obs. of June 19, at 0 <sup>h</sup> 30 <sup>m</sup> p.m. Dispersion 50°.	Concluded Mean for every Line.	Single Lines and Centres of Double Lines.	Differences.		
							Width of Doubles.	Dist. of sides.	Dist. of centres.
Sixth pair, Component 1	2.0	36,817	36,812	36,814	36,814	36,817	7		
2	2.0	826	818	819	821			14	21
Seventh pair, Component 1	2.5	36,840	36,833	36,834	36,835	36,838	6		
2	2.5	848	839	839	841			14	20
Eighth pair, Component 1	2.5	36,860	36,854	36,853	36,855	36,858	5		
2	2.5	867	858	858	860			14	18
Ninth pair, Component 1	2.0	36,879	36,874	36,874	36,874	36,876	5		
2	2.0	884	878	878	879			12	16
Tenth pair, Component 1	1.5	36,897	36,890	36,889	36,891	36,892	3		
2	1.5	900	893	892	894			13	15
Eleventh line, of Preliminary band, a Single one	1.0	36,912	36,904	36,906	36,907	36,907		(17)	(19)
ATTACHED BAND.									
First pair, Component 1	0.3	36,923	36,923	36,925	36,924	36,926	4		
2	0.3	927	927	930	928			6	10

Second pair, Component 1.	0.5	36,930	36,933	36,937	36,934	36,936	3		
2	0.5	934	936	940	937			5	7
Third pair, Component 1	0.8	36,939	36,943	36,944	36,942	36,943	2		
2	0.8	944	945	946	944			5	8?
Fourth pair?	1.0	36,949	36,950	36,949	36,949?				
Fifth pair?	1.0	36,955	36,953	36,953	36,954	36,951?		5?	5?
Sixth pair?	0.8		36,957	36,958	36,958	36,956?		4?	—
A strong single line	2.0	36,961	36,962	36,962	36,962	36,962		4?	
Another ditto	2.0	36,968	36,968	36,968	36,968	36,968		6	6
Another fainter	1.5	36,975	36,975	36,974	36,975	36,975		7	7
								(7)	(8)
B LINE.									
First side of bundle	} 3.0	36,984	36,983 {	36,982	36,982	36,983		2	
Second ditto				984	984				
Pale space begins				36,984	36,984				
Ditto ends				988	990				7
Terminal line	2.0	36,994	36,990	36,988	36,990	36,990			